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Wet Auger: Respirable Dust Control for Underground Auger Continuous Mining Machines

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WET AUGER: RESPIRABLE DUST CONTROL FOR UNDERGROUND AUGER CONTINUOUS MINING MACHINES

by

John J. Pendergast,[1] Willis D. Ison,[2] and William H. Sutherland[3]

ABSTRACT

In an effort to reduce the high-level respirable dust concentrations produced by auger-type continuous miners to the 2.0 mg/m^3 (milligrams of dust per cubic meter of air) standard, a water transfer mechanism has been developed to pass water from the stationary miner through the hollow core of the rotating augers to spray nozzles installed on the augers. This through-auger spray system has reduced the average respirable dust concentrations of the return-side jacksetter (high-risk occupation), and the milligrams of airborne respirable dust generated from each ton of coal produced, by more than 60 percent.

INTRODUCTION

In accordance with the provisions of the Federal Coal Mine Health and Safety Act of 1969, the Mining Enforcement and Safety Administration and coal mine operators regularly sample the respirable dust generated by coal mining equipment. Samples collected in areas where auger-type continuous miners operate disclose high levels of respirable dust concentrations. Samples collected by Coal Mine Health and Safety District 5 personnel in the environment of the high-risk occupation on this type of mining equipment ranged from 2.0 to 31.0 mg/m^3. Various dust control measures were initiated with a minimum of success. However, in mid-1972, high-risk dust concentrations continued to remain excessively high as indicated by the data shown below, with over 76 percent of the samples exceeding 3.0 mg/m^3, which was the dust level standard established by the Federal Coal Mine Health and Safety Act of 1969. That standard was changed to 2.0 mg/m^3 on December 30, 1972.

Respirable dust concentration (mg/m^3).....	2.0-3.1	3.1-5.0	5.1-10.0	10.1-20.0	20.1-30.0	30.0
No. of sections	10	3	11	14	3	1

[1] Supervisory coal mine technical specialist.
[2] Coal mine inspection supervisor.
[3] Mining engineer.

Therefore in early 1973, Coal Mine Health and Safety District 5 and Buchanan and Sons Coal Company, Incorporated, initiated a joint effort to devise a system for passing water to spray nozzles installed on the rotating augers of an auger-type continuous miner in the company's No. 19 mine at Pound, Wise County, Va. The major problem in devising such a system was the development of a mechanism for transferring the water from the stationary miner into the rotating augers. Buchanan and Sons Coal Company, Incorporated, contracted the design and fabrication of the transfer mechanism to the Wise Manufacturing and Equipment Company, Wise, Va. An operable mechanism was developed and successfully installed on a Wilcox Manufacturing Company Mark 20[4] miner in the No. 19 mine.

The Bureau of Mines became interested in this joint project after it was begun and provided funding for its development. This report describes the development of this system, and the collection of data to evaluate the system, and presents a summary of the results of using water on the augers.

ACKNOWLEDGMENT

Messrs. Ray Buchanan, Kenneth Buchanan, Eddy Buchanan, and Taylor Mullins of Buchanan and Sons Coal Company, Incorporated, provided the mine, the mining equipment, and design guidance for this project. Mr. Vernon Osborne of Wise Manufacturing and Equipment Company designed and built the water transfer mechanism for the project. Messrs. Kelly Strebig and H. W. Zeller, Bureau of Mines personnel, provided sampling equipment and advice on sampling techniques. The employees of Buchanan and Sons Coal Company, Incorporated, provided valuable assistance and suggestions throughout the project.

DESCRIPTION OF TEST SITE

The No. 19 mine, opened by drifts, is in the Upper Bolling coalbed which averages 38 inches in thickness. In addition to showing the location of dust sampling points, figure 1 also shows the three parallel entry system which was developed on 60-foot centers with crosscuts on 87-1/2-foot centers. Entries and crosscuts were driven 28 feet wide. Water from an underground sump was delivered to the section through a 2-inch-diameter metal pipe using a Royal No. 15 bean pump. A 600-foot, 3/4-inch-diameter, high-pressure rubber hose delivered water from the pump to the continuous miner. Coal was extracted using a Wilcox Manufacturing Company Mark 20 auger-type continuous miner. A combination of blowing and exhausting face ventilation was installed in each working place, using line brattice.

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[4]Reference to specific brand names, equipment, or trade names in this report is made to facilitate understanding and does not imply endorsement by the Mining Enforcement and Safety Administration.

1 - Package in intake air
2 - Package in return air
3 - Package on continuous miner
4 - Personal sampler on return side jacksetter

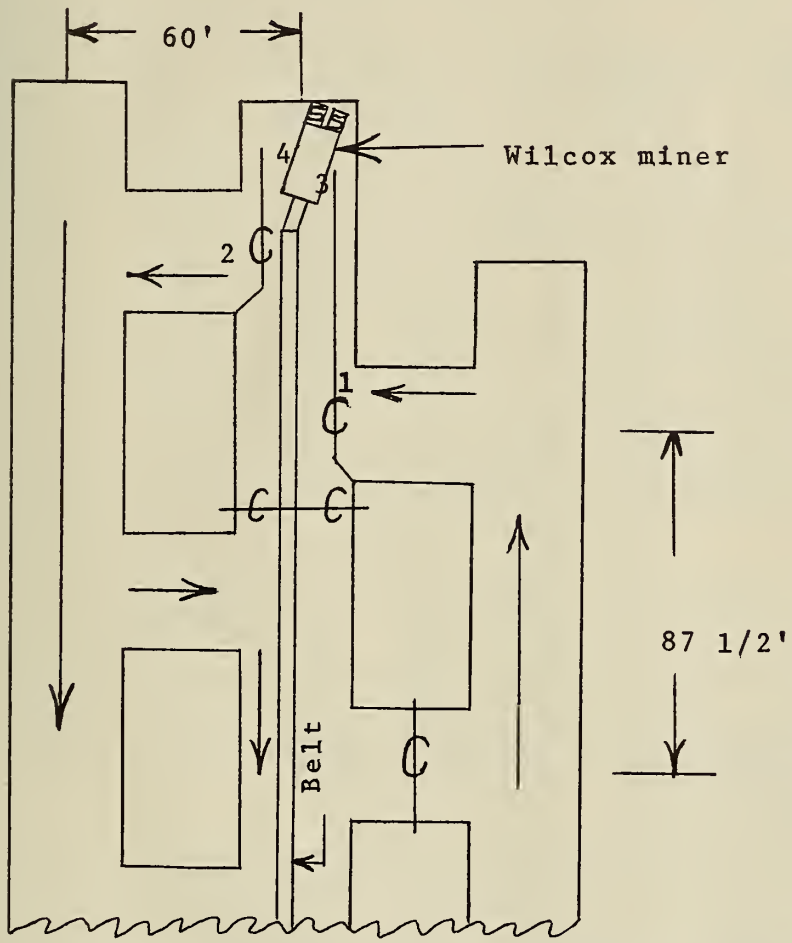

FIGURE 1. - Location of dust sampling points.

DATA COLLECTION PROCEDURES

Respirable dust samples were collected at four locations on the working section as follows: (a) behind the intake line brattice, (b) on the continuous miner near the miner operator, (c) in the environment of the return-side jacksetter, and (d) behind the return line brattice.

The air quantity returning from the face was measured near the end of the line brattice in each working place at the point where the dust samplers were located. The wide range in the ventilation, 2,000 to 6,900 cfm, was due to the varying length of the face line brattice, 0 to 125 feet, and due to a major change in the ventilation system during the wet auger testing.

Water pressure measurements were obtained by removing a spray nozzle from the miner and inserting a pressure gage in its place.

Production tonnage was calculated by measuring the advance of the continuous miner. The wide difference in tonnage, 50 to 350 tons per shift, was due to the roof conditions varying from poor to excellent.

Respirable dust samples on the continuous miner operator and the return-side jacksetter were taken portal-to-portal. The intake air and return air dust samplers were operated only during the time on the working section. The respirable dust concentrations of the intake air, the return air, and the continuous miner operator were measured with a package of personal samplers modified with pulsation dampeners, and MRE samplers. These packages were placed behind the intake and return line brattices, and on the continuous miner. The return-side jacksetter wore a modified personal sampler. The personal sampler

data was converted to MRE equivalents, using a 1.38 conversion factor,[5] so that all respirable dust concentrations are reported as MRE equivalents. The samplers were calibrated after each 56 hours of use. Table 1 gives a summary of the data collected. Figure 1 shows the location of the sampling points.

TABLE 1. - Summary of experimental data

Auger	Dry range	Wet range	Dry average	Wet average	Percent reduction
Dates.....	May 7-21, 1973	July 15-Aug. 21, 1973	-	-	-
Days sampled.....	8	17	-	-	-
Production (tons).....	88-209	50-350	158	179	-
Ventilation return (cfm).....	2,000-4,300	2,000-6,900	2,900	3,700	-
Water pressure (psi-flow).....	88-155	70-140	120	100	-
Water (gpt).....	3.9-7.2	5.1-11.1	6.0	8.1	-
No. of sprays.....	[1]8-14	[2]15-16	11	15	-
Respirable dust (mg/m^3) intake air...	0.1-0.5	0.1-0.3	0.16	0.15	-
Respirable dust (mg/m^3) C.M.O.[3].....	0.9-3.9	1.0-3.5	2.1	1.2	43
Respirable dust (mg/m^3) return-side jacksetter (high-risk).....	4.2-12.5	[4]0.2-5.6	7.7	2.7	65
Respirable dust (mg/m^3) return air...	2.0-10.2	0.1-3.9	4.2	1.5	64
Respirable dust generated (mg/ton)[5]..	480-1,640	105-558	975	382	61

[1] All on front of continuous miner frame.
[2] Twelve on augers, rest on miner frame.
[3] Continuous miner operator.
[4] Very low tonnage on date of 0.2 mg/m^3 sample. The next lowest sample was 1.2 mg/m^3.
[5] Milligrams of airborne respirable dust generated per ton of coal produced. (mg/m^3 dust in return air minus mg/m^3 dust in intake air times cfm ventilation return times 0.0283 m^3/ft^3 times minutes dust sampler operated divided by the tons produced.)

[5] Tomb, Thomas F. Comparison of Respirable Dust Concentrations Measured With MRE and Modified Personal Gravimetric Sampling Equipment. BuMines RI 7772, 1973, 29 pp.

DISCUSSION

Since the effective date of the Mandatory Health Standards-Underground Coal Mines 30 CFR 70, the Mining Enforcement and Safety Administration and coal mine operators have regularly sampled respirable dust to which miners are exposed in underground coal mines. Generally, the majority of the dust is produced by mining equipment operated in face areas.

Prior to the enactment of the Federal Coal Mine Health and Safety Act of 1969, environmental respirable dust surveys were made in selected underground coal mines of the country under the direction of the Pittsburgh Field Health Group. Results indicated that the respirable dust levels to which some miners in certain occupations were exposed were consistently higher than that of others; thus, the high-risk concept was developed. The high-risk concept assumes that if the respirable dust exposure of the worker normally subjected to the highest dust concentration is at or below the standard, then the exposure of all other workers in that working section will be below the standard. Operators of continuous mining machines were found to be the high-risk occupation. However, additional surveys revealed that the high-risk occupation on auger-type continuous miners was the return-side jacksetter. Samples collected by Coal Mine Health and Safety District 5 personnel in the environment of that high-risk occupation during mid-1972 disclosed high levels of respirable dust concentrations varying from 2.0 mg/m^3 to 31.0 mg/m^3 with more than 69 percent of these samples over 5.0 mg/m^3.

In an effort to reduce respirable dust levels, various control measures have been utilized, such as: increased ventilation, different methods of ventilating in the face areas, providing more water on equipment, increasing water pressure, and the use of different spray sizes and patterns. Since only limited success was achieved with these methods, a new method was devised whereby water was injected through the rotating augers. It was believed this could be accomplished by passing water into the hollow auger core and thence through sprays installed on the core. Early in 1973, meetings between personnel of District 5 and Buchanan and Sons Coal Company, Incorporated, to discuss this method of dust control resulted in a joint effort to devise a transfer mechanism which required no major change to the machine. Buchanan and Sons Coal Company, Incorporated, contracted with Wise Manufacturing and Equipment Company, Wise, Va., to design and fabricate a water transfer mechanism that could be installed between the augers and drive units on one of their Wilcox auger-type continuous miners. The water transfer units were developed and installed on the test machine in June 1973 (figs. 2 and 3). Six BD 2 Spraying System nozzles were spaced around each auger, and three were installed across the front of the miner. During the first experiment with the test machine, the packing gland seal of the left auger transfer unit failed after the machine advanced only 12 feet, however, a visual observation of the reduction of dust generated during this brief period of operating time was

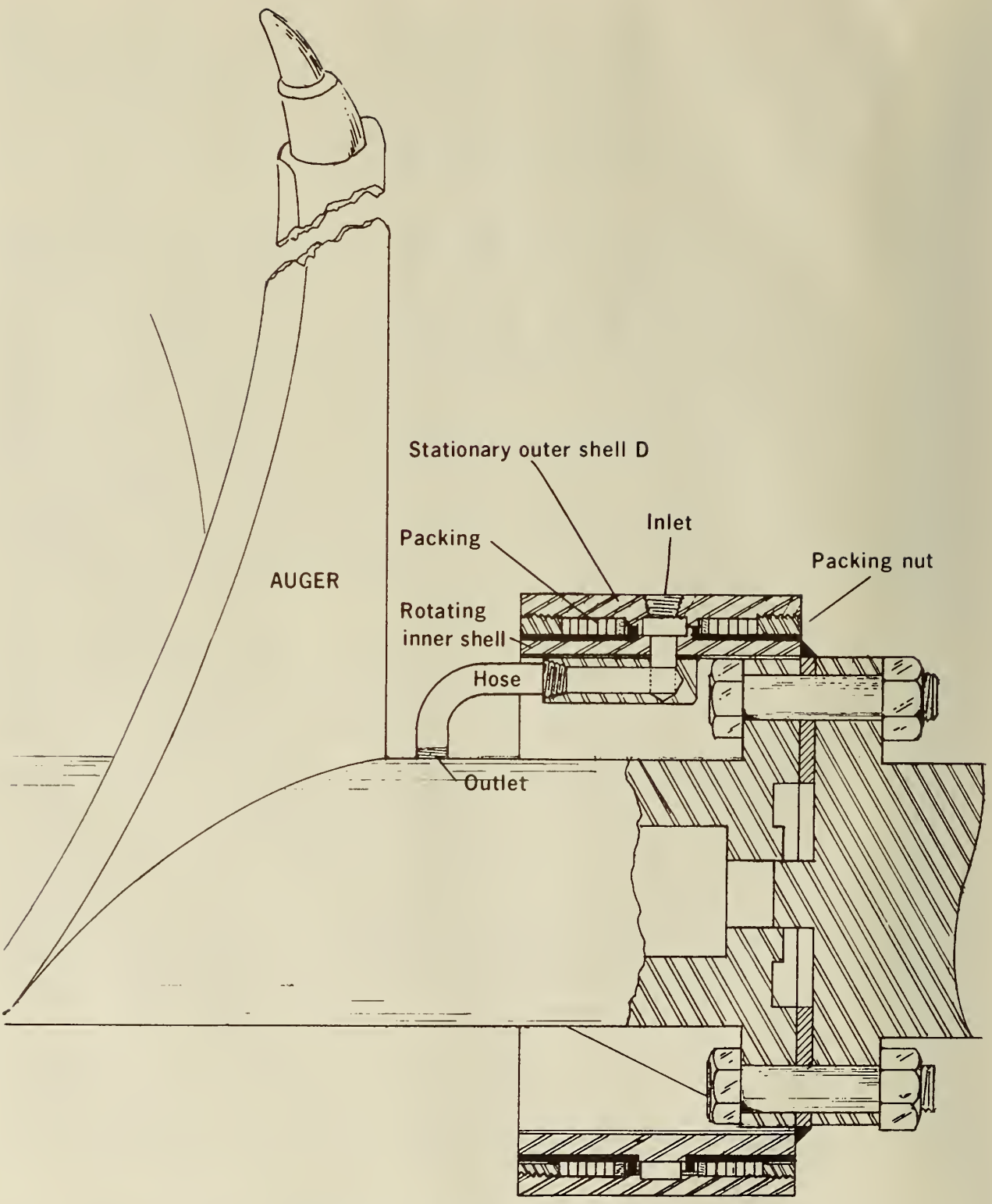

FIGURE 2. - Water transfer mechanism.

FIGURE 3. - Continuous miner and water transfer mechanism.

impressive (figs. 4 and 5). The units were removed from the machine and returned to the Wise Manufacturing and Equipment Company. A search was begun for an improved packing material which was eventually obtained from the Raybestos Manhattan Company. After the units were equipped with this new packing material, they were again installed on the miner and successfully operated for more than 6 months. Results of samples collected during tests indicate an average reduction of 60 percent in dust concentrations in the return air and on the return-side jacksetter (high-risk) occupation.

The Bureau of Mines Twin City Research Center became interested in this joint venture after it was begun and provided funding for further development. Auger drive shafts have since been drilled on another machine of the same type by Buchanan and Sons Coal Company, Incorporated, and a commercially available water transfer unit has been adapted to pass water from the stationary machine through the rotating augers. This method is also proving successful. Future experiments are planned in using surfactants and ventilation changes to control the respirable dust.

FIGURE 4. - Dust pattern in face-dry auger mining coal.

FIGURE 5. - Dust pattern in face-wet auger mining coal.

CONCLUSIONS

During this experiment, the water transfer mechanism performed satisfactorily for over 6 months. The use of water on the augers reduced the respirable dust in the return air from 975 to 382 mg/ton (milligrams per ton). The respirable dust in the environment of the high-risk occupation (return-side jacksetter) was reduced from an average of 7.7 to 2.7 mg/m^3.

Results indicate that with nominal changes in ventilation, administrative controls, and the use of surfactants, the high-risk environment can be reduced to the present 2.0 mg/m^3 standard. Experiments are continuing in this area and results will be published as further studies are completed.

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